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FRACTURE OF THE SKULL FROM THE DISCHARGE OF A SHOT-GUN INTO THE LEFT ORBIT.

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Owing to the meagre amount of medical literature about the above-mentioned injury, which must be fairly common, and which is of considerable importance from a medico-legal point of view, I have given the results of the autopsy in some detail.

The leading points of the case in point are briefly as follows : George Clay, a colored man, aged 39, Pullman car porter, in easy circumstances and with no known enemies, left his house at 11 A.M. on Wednesday, April 20th, 1891, to go shooting muskrats and pike in the creeks near Lachine, P.Q. He was thought to have about \$60 in his purse, and carried a revolver in addition to an old double-barreled, muzzle-loading shotgun. Having expressed the intention of returning for supper the same evening his friends were alarmed when he did not appear. Two days later his body was found, face downwards, in a creek near Lachine, at a point where it passed into a railway culvert, and where a rough bridge was formed by a telegraph pole and a plank lying obliquely upon it. A substance resembling blood and brains was found on the upper surface of this plank and the body lay beneath it in the water. His hat lay in a bush close at hand. A suspicious feature of the case was that the gun was

found twenty feet from the body, lying propped up against the railway embankment. The right barrel had been fired. Neither money or revolver were found on the body, though the watch was not missing, and was found to have stopped at six o'clock.

The other circumstances of the case are irrelevant for my present purpose.

A medical man practising in the parish having been called upon to perform an autopsy, deposed to the presence of a gunshot wound of the left orbit, passing in a direction obliquely upwards to the vertex, and an appearance resembling a burn of the left cheek; also a very extensive comminuted depressed fracture of the skull without accompanying hemorrhage. A partial examination only was made, the brain not being removed. About twenty grains of shot were found near the vertex.

The opinion given was to the effect that the gunshot was accidental and had caused death, but that after death the head had been subjected to violence, leading to the fracture of the skull. This finding not being satisfactory to the jury, an examination of the body was ordered, and I happened to be the person selected to perform it.

The only really suspicious element in the case was the distance from the body at which the gun was found, but this was subsequently reconciled with the theory of accidental death by the deposition of a body of Oblat Fathers from a neighbouring monastery, who, while out taking a walk in the afternoon of the day following the tragedy, and twenty-four hours previous to the finding of the body by the deceased's relatives, saw the gun lying on the plank beneath which the body lay. These gentlemen did not feel at liberty to mention the fact of their having seen the body at all until about a week later.

This explanation of the gun being found at a distance from the body was compatible with a theory of accidental death, and the experimental evidence that a gunshot could produce all the injuries found in the deceased of course disposed of the idea of injury to the skull being due in any part to blows on the head inflicted after death, and led subsequently to a verdict of accidental death being rendered.

REPORT OF THE RE-EXAMINATION OF THE BODY OF GEORGE CLAY.

Examination made on the premises of Mr. Armstrong, undertaker, of Lachine, at 3 p.m. on April 25th, 1892, five days after presumed date of death.

The body, which was identified in my presence as that of the deceased George Clay, aged 39, was that of a well-built, well-nourished coloured man, of middle height. Rigor mortis present at all joints. No signs of decomposition. The previous examination had been confined to an examination of the injuries in the head, the only dissection made being an incision in the scalp extending from the root of the nose across the forehead as far back as the vertex. This incision had been closed with sutures. The body was lying in a coffin and was dressed in burial clothes. The face bore signs of having been cleaned since the discovery of the body. A careful examination of the whole body after removal of all the clothes failed to show any injuries or marks of violence excepting those subsequently mentioned in the head. None of the bones were fractured. The hands were open and showed no marks to indicate a struggle. The dirt beneath the nails appeared undisturbed.

Head.—In the region of the left orbit is a large, rounded, lacerated wound, $1\frac{3}{4}$ inches in diameter, extending from between the left eyebrow to the level of the malar prominence. The edges of the wound are thin, torn and blackened, and show traces of small black grains apparently gunpowder. The entire left eyeball and the contents of the left orbit had been displaced. The hair and eyebrows were not burned. There were no signs of the skin of the face being burned except at the margins of the wound.* The nostrils were filled with clotted blood. The outline of the cranium showed flattening and depression over the

* In the report of the previous autopsy a statement was made to the effect that there was a burn on the left cheek. I was not able to find any trace of this at the time when I made the second autopsy. The explanation of this apparent discrepancy probably is that the appearance described as a burn was due to blackening of the face by soot from the powder-smoke. This might be mistaken for a burn. The soot had probably been washed off by the undertaker in laying out the body. In my experiments with gunshot wounds of dead bodies I found always extensive blackening of the skin from smoke, but no burning.

vertex and in the region of the left temple. On pressing lightly with the hands, the cranial bones could be felt to move and crepitate on one another. Owing to the previous examination having disturbed the relation of the parts I was unable to determine what the exact position of the bones had been immediately after the injury as a direct consequence of it.

The scalp was reflected in the usual manner after making an incision from behind the ears passing over the vertex. The scalp was found to be remarkably thick and dense. It showed no trace of external injury. The tissues between the scalp and the bone showed nothing abnormal except a slight amount of ecchymosis in the left parietal region, near the vertex.

After removing the skull-cap by sawing around it below the level of the orbit, the brain was examined. All the pieces of bone were carefully preserved, but it was subsequently found that the portions of bones corresponding to the left lower parietal and frontal regions were missing. Whether this was due to their having been removed at the first examination and not replaced I am unable to say. From the appearance of the soft tissues in this region it appeared as if the injury to the bones had been more severe in this region than elsewhere.

The dura mater, especially in the anterior portion of the falx, appeared to be much lacerated, but the disturbance due to the previous examination made it impossible to state how much of this laceration was due to the effects of the gunshot.

From beneath the skull-cap and in the brain tissue near the vertex I removed 48 grains of No. 4 shot. Most of the grains were much flattened. They weighed altogether half an ounce. Some of the grains were found in the fissures caused by the fractures in the bone.

The brain was found to be firm and in good condition ; it had not been removed or disturbed at the previous examination. It showed a lacerated area of between two and four inches in diameter, extending obliquely upwards and backwards from the left orbit to the vertex. The laceration was confined to the neighbourhood of the median line, and involved the anterior extremity of the corpus callosum and the inner surface of both

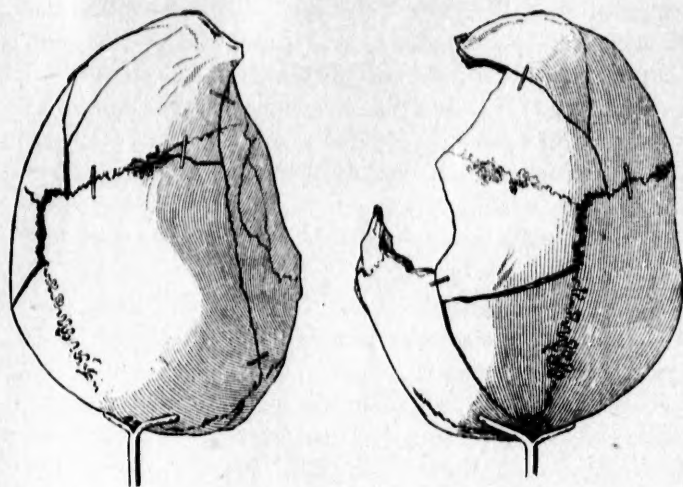
hemispheres anteriorly. The left hemisphere was more extensively lacerated than the right, but the inner frontal and orbital lobes on both sides were almost completely disintegrated.

There was very little hemorrhage along the course of the wound, and no large blood-clot was seen. The brain tissue contained a considerable quantity of blood in its vessels and was not pale. The ventricles were normal and free from blood-clot. The ganglia at the base lay outside the track of the wound and were not injured.

After the removal of the brain the posterior half of the left eyeball with the optic nerve attached was found lying to the right of the optic chiasm.

At the base of the skull there was found extensive laceration and fracture in the vicinity of the left orbit, the injury extending over an inch to the right of the median line. The bones of the orbital plate of the frontal, together with the lesser wing of the sphenoid on the left side and the turbinated and ethmoid bones, were comminuted into minute fragments. Except in this region, the base of the skull was free from fracture, and the lines of fracture subsequently described in the skull-cap did not extend as far down as the base.

The whole of the skull-cap was removed to Montreal and prepared and mounted by Mr. J. Bailly, articulator. The location of the lines of fracture will be understood from the following description and from the accompanying



(FIG. 1.)

The cranial bones were thicker and denser than in the case of European skulls, though not unusually thick for an African. The diploe was scanty and the tables relatively thick. The measurements were : thickness in occipital region. 1 cm, of which 5 mm. was taken by the outer table, 3 mm. by greatly sclerosed cancellous tissue, and 2 mm. by the inner table. In the parietal region the total thickness was 7 mm., of which 2 mm. was occupied by outer table, 1.5 mm. by the inner table, and 3.5 mm. by the diploe. The length from glabella to occipital protuberance was 19 cm. (7.5 inches) ; the diameter in mastoid region was 13 cm. (5.3 inches) ; and in the anterior temporal region, 9 cm. (3.5 inches). The skull outline was somewhat unsymmetrical and the thickness in particular spots varied considerably from the means given, being at one point in the right temporal region only 0.5 mm. (one-fiftieth of an inch). Both tables were equally involved in the fracture, and nowhere was any splintering of the inner table observed.

The following lines of fracture were observed, eight in number, including separation of the sutures :

No. 1—A fracture extending forwards from a point in the

coronal suture, half an inch to the right of the middle line and running to the left external angular process of the frontal bone.

No. 2—A fracture branching off from No. 1 at a point one inch anterior to the coronal suture and extending to the inner third of the right supra-orbital ridge.

No. 3—A separation of the anterior, $1\frac{1}{2}$ inches, of the sagittal suture.

No. 4—A crooked line of fracture from the left frontal eminence to the left parietal eminence.

No. 5—A continuation of No. 4 from the left parietal eminence to the posterior extremity of the sagittal suture in the region of the Wormian bones.

No. 6—A line of fracture extending from the posterior extremity of No. 3 an inch from the anterior extremity of the sagittal suture and running to the left parietal eminence at the junction of Nos. 4 and 5.

No. 7—A curved line of fracture with the convexity upwards extending from the right external angular process to the right limb of the lambdoidal suture, passing through the parietal bone just above the squamous suture.

No. 8—A separation of the right half of the coronal suture extending three inches from the coronal suture and then continuing as a fracture of the parietal bone and joining No. 7 at a point half an inch posterior to the coronal suture.

On the inner surface of the cranium were seen eighteen small round marks of lead on the bones; these were scattered over an area four inches in length by two inches laterally, and lay along the vertex. Lead marks were also seen on the fractured edges of the bones. None of the shot appeared to have penetrated the bones.

The thoracic and abdominal organs were examined and found free from all traces of violence. The abdomen, on opening, showed the peritoneum to be smooth and the position of the viscera normal. The stomach was very small and looked contracted. The level of the diaphragm corresponded to the third space on the right side and the fourth rib on the left side. The pleural cavities each contained about four ounces of clear reddish

serous fluid. The lungs were crepitant throughout ; the bases felt sodden ; on section both organs were found to be œdematous. Both lungs contained a fair amount of blood ; the bronchi were found free from foreign substance ; the bronchial mucosa was pale. The heart was small and its ventricles contracted ; valves normal. Spleen small in size, normal. Kidneys normal. Bladder contained about 4 ozs. of clear urine. Liver normal, contained a fair amount of blood. Stomach small and nearly empty ; contained about two ounces of fully digested food ; mucosa normal. Intestines normal.

Microscopical examination of the blood-stained substances found on the plank across the creek showed them to contain brain tissue, recognised in the form of granular detritus and myelin drops. They also contained red-blood corpuscles averaging seven to eight micromillimeters in diameter.

Summary.—The only injury found is a severe gunshot wound of the left orbit, entering the skull in an obliquely upward and backward direction, and lacerating the brain in the area through which it traversed. The severity of the injury was in itself sufficient to cause death. That death was probably not quite instantaneous is probable from the œdema of the lungs, but the absence of severe hemorrhage shows that it must have very soon followed the injury. Loss of consciousness must have been instantaneous from the severe shock. The oblique direction of the wound makes it one which could not well have been intentionally caused by a weapon in the hands of another person than the victim, as it would be impossible to take aim so as to produce this wound except under unusual circumstances, leading to the victim being either several feet higher up than the assailant or else lying down face uppermost. The wound is one which could very well have been caused accidentally by the discharge of the gun while the muzzle was grasped by the hand of the deceased.

The condition of the stomach agrees with the hour at which the watch stopped, placing the hour of death and immersion in the water at 6 P.M. on April 20th, the day of disappearance.

A point of special interest was the totally different character of the cranial fracture in this case from the appearances met with in fractures produced by direct violence from without, such as results from blows or a fall on the head, etc. The difference consists in the marked tendency to separation of the sutures in the case of the gunshot injury of the cranial vault from within, and the fact that the lines of fracture do not tend to run across the base of the skull. This distinction can be readily explained on mechanical grounds when the totally different relation of an arched cavity like the cranium to external and internal shocks is borne in mind. An expansive force acting from within would naturally tend to separate the sutures, while a crushing force acting from without would have no such tendency. An external force impinging on the roof of the cranial arch makes itself felt earliest and most severely at the base, while an internal force directed upward expends itself entirely upon the roof of the skull.

That this difference in the distribution of the lesions has not previously been noted is perhaps due to the fact that the commonest form in which gunshot or pistolshot wounds at short range present themselves for examination is in the case of suicides, and when the shot is fired through one of the natural orifices, the mouth is that commonly chosen, in which case the base of the sphenoid bone lies directly in the line of fire, and is, naturally, shattered. In cases where the entire skull is not shattered to fragments, the scalp is perforated by the bullet in its exit.

In the present instance it was my fortune to meet with a case where a most extensive fracture of the skull accompanying a gunshot wound of the orbit, made at short range, was not associated with any wound of exit or injury to the scalp.

Thinking that injuries of this nature arising from the careless handling of firearms must be fairly frequent, I carefully searched all the available sources of information in the shape of text-books on medical jurisprudence and medico-legal literature, particularly the files of the *Viertel-jahresschrift für gerichtliche Medicin*, but was unable to find any case where a gunshot wound had fractured the skull from within without producing a wound of

exit. I was also disappointed in my expectation of finding parallel cases reported among the forty thousand cases of gunshot wound of the head analysed and tabulated in the *Medical and Chirurgical History of the War of the Rebellion*, or in any special treatises on gunshot wounds and the museum catalogues which I was able to consult.

In anticipation of a possible expression of opinion to the effect that there is no inherent improbability of a fracture of the skull from an injury such as is recorded here, being unaccompanied by any evidences of injury to the scalp, I must state that the experimental investigation on the production of fractures of this nature was undertaken under conditions where the medical evidence at a previous autopsy had led to the presumption that my fracture of the skull had been produced after death by a separate act of violence independent of the gunshot, and that it was necessary to produce objective evidence sufficiently convincing to change the views of a coroner's jury.

The medical evidence given at the first autopsy had led to the presumption that the fracture of the skull was due to a separate act of violence inflicted through blows from a blunt, smooth instrument, but my own examination convinced me that the gunshot wound was capable of having produced all the fractures found in the skull.

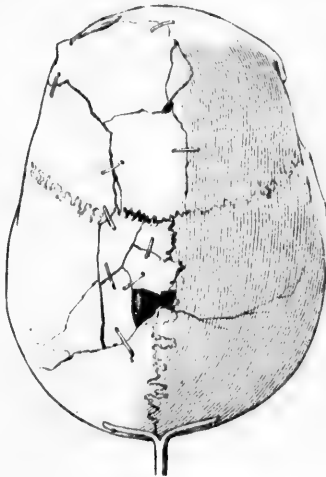
Finding that there are no existing records of autopsies on injuries of this description, I obtained permission from the Attorney-General for the Province of Quebec to make some experiments in order to determine this point. In making these I received valuable assistance from Mr. Bailly.

The following details were observed in my experiments: I employed the gun used by the deceased, using a charge of powder slightly less than 2 drs. to correspond with the amount contained in the measuring cup of the powder flask found on his body: the charge of shot used was three-quarters of an ounce, as this amount corresponded with the amount found within the skull.

It will be remembered that the whole effects of the charge were concentrated within an area of an inch and three-quarters,

as this was the size of the wound of the face. To prevent the shot from scattering more widely than this, it was found, by shooting at a plank at various distances, that the distance must not exceed three feet.

Having procured a suitable anatomical subject, and taking a somewhat smaller charge of powder corresponding with the thinner skull of my subject, a charge was fired at a range of two and a half feet into the left orbit, imitating as nearly as possible the direction of the wound in the case of Clay. A fracture of the skull (shown in Fig. 2) was produced, which was practically identical with that found in Clay's skull, and the scalp was also found to be practically uninjured, not being perforated by the shot.



(FIG. 2.)

Setting aside the fact that the fracture of the experiment happens to be somewhat more severe than that in Clay's case, as might naturally be expected in dealing with a much thinner skull, there is a wonderfully close resemblance in what I may term the quality of the injury in both cases. Of the eight lines of fracture described above in Clay's skull, no less than seven found their counterparts in the fracture experimentally produced.

A still more striking proof of the close relation between the experimental fracture and that of Clay's skull is that in both there was extensive separation of the coronal and sagittal sutures. In fractures of the skull from the effects of blows or falls on the head, this separation of the sutures appears to be most unusual, if it ever occurs at all.

In the museum of McGill Medical College, amongst numerous specimens of fracture of the skull there is only one which presents this special feature, and this is a case of gunshot wound. The reason of this seems evident when the arched form of the cranial roof is taken into account, as external pressure or violence would tend to press the sutures more closely together, whereas pressure or shock from within would tend to separate them.

That the charge did not penetrate the skullcap and scalp and produce a wound of exit is apparently due partly to the thickness of the skull and partly to the elastic resistance afforded by the extremely thick scalp. In this connection the scattered position of the shot over an area of eight square inches, as indicated by the lead-marks on the inner table, must also be taken into account. The distance of the muzzle of the gun from the head also modifies the effect of the shot, and an increase of the distance lessens the tendency to perforation. Thus I found in another experiment, that with the same charge fired at a distance of one foot only, the shot passed quite through skullcap and scalp and buried themselves deeply in a plank placed behind. That the fracture was in any measure caused by the expansion of gas due to the explosion of the powder does not seem probable. In a third experiment we placed the muzzle of the gun directly against the left eye of a subject with a very thick skull, and with the same charge of powder as in the last-named experiment the whole of the top of the head was completely blown off and the brain entirely disintegrated. In view of the fact that at the intermediate range of one foot a circumscribed perforating lesion was produced without any general, diffuse explosive effect, it is improbable that the explosive force of the shot fired at two and a half feet was the immediate cause of the fracture in Clay's skull.

Another point worthy of consideration in this case is, that the fractures did not run along the base either in the original case or in the experimental fractures. Now it is well known that the most delicate test of violence acting on the cranium from without is the production of a fracture at the base, the force being concentrated there by means of what we are in the habit of calling *contre coup*. Fractures at the base uniformly occur as the result of a blow on the vertex too weak to fracture the bones of the cranial vault, and I have never examined a case of extensive fracture of the skull from external violence without having found likewise fracture of the base.

In addition to the direct and indirect evidence in favour of the violence acting from within rather than from without in the case of Clay, I cannot conceive how such extensive injury of the bones could have been brought about by external violence without leaving traces of injury to the scalp.

The assumption that two separate acts of violence were needed to produce the injuries found in Clay's body seems unnecessary.

As already stated, my reason for reporting the case at such length was the absence of records of similar cases from medical literature. The opinion given at the first autopsy that two separate modes of injury had occurred, though to my mind quite erroneous and "far-fetched," could best be controverted by experimental evidence.

Anyone trusting to the information given in textbooks would be completely at fault to find any precedent for assuming that the gunshot had produced all the injuries.

I may also correct a misleading statement current in medico-legal textbooks to the effect that fractures and lacerations unattended by hemorrhage have necessarily been produced post-mortem. It was shown by Arnold Paltauf of Vienna, now three years ago (*Wiener klin. Wochenschr.*, No. 37, 1889), that extensive fractures of the skull, ribs and other bones, and even rupture of the liver, may be unaccompanied by any hemorrhage even when the patients live for several hours after the injury,

provided that the general blood-pressure is lowered to nearly *nil* by either a profound condition of collapse from shock or a copious hemorrhage from other parts. Blood cannot be extravasated into the tissues unless the intra-vascular pressure at the point of rupture exceed the resistance offered by the tissues.

I would point out in conclusion that my results, while correcting and explaining in some respects those of the colleague who performed the first autopsy, also established the accuracy of his statement that the case was one of accidental death.

My thanks are especially due to Dr. F. J. Shepherd for having furnished me with anatomical material and facilities for the experiments, without which a successful result could not well have been obtained in the short interval afforded by the adjournment of an inquest.

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